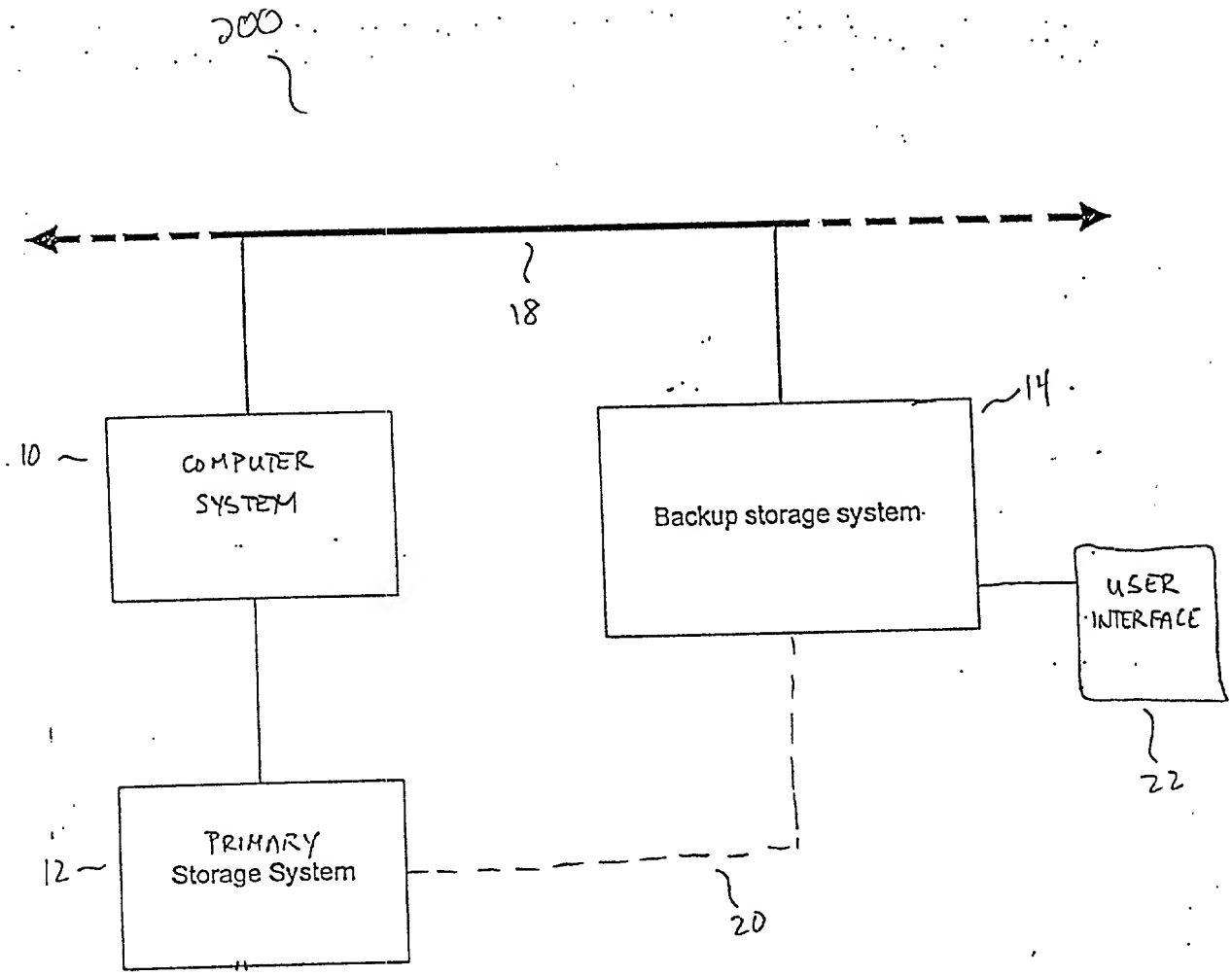

FIG. 1
(PRIOR ART)

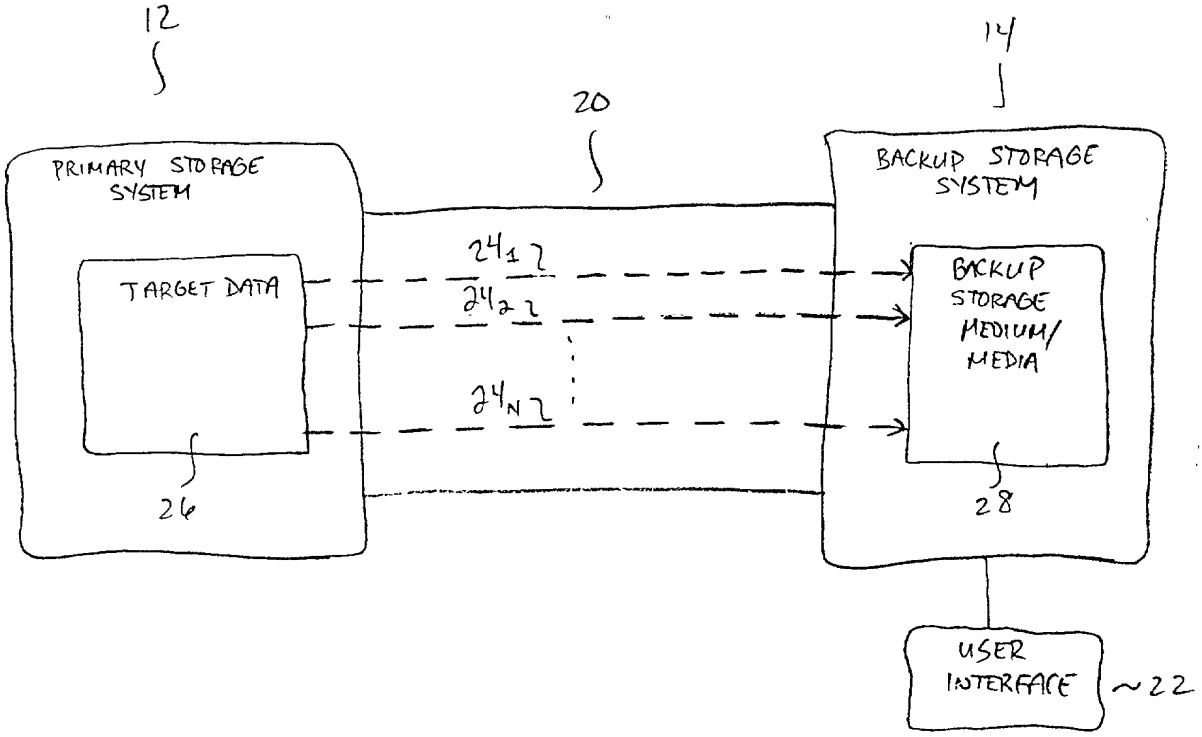

FIG. 2
(PRIOR ART)

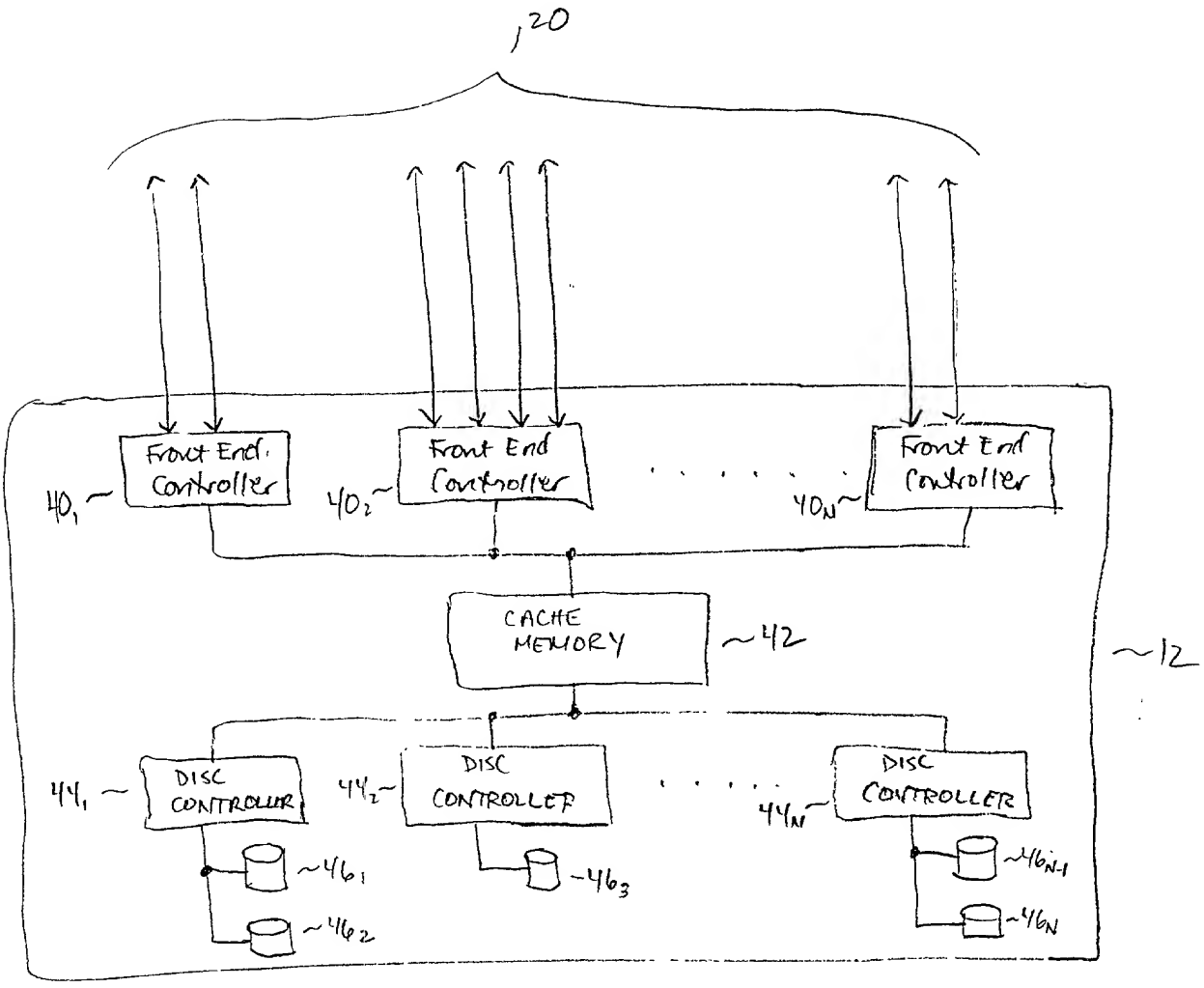

FIG 3
(PRIOR ART)

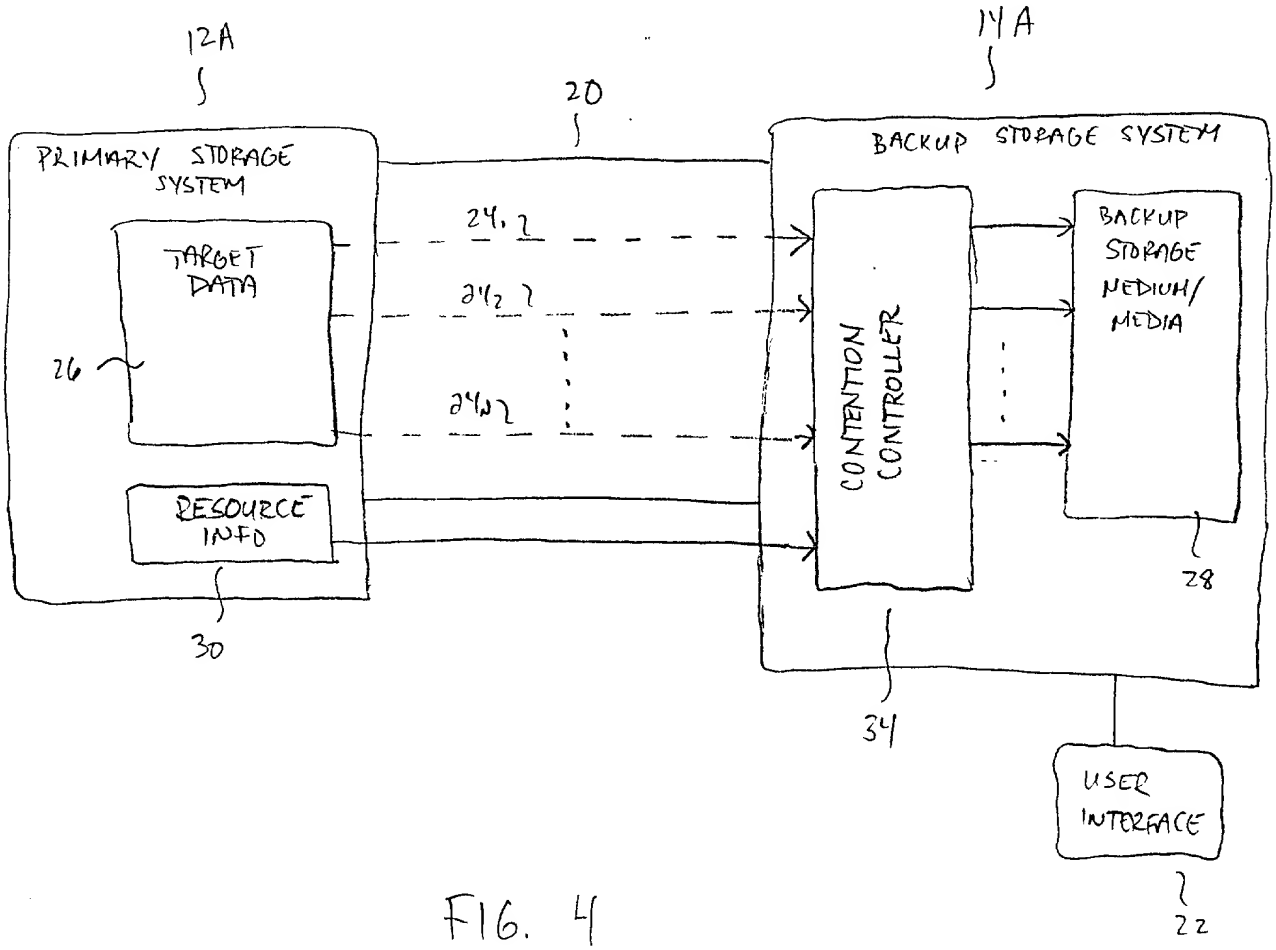
12A
14A
20
PRIMARY STORAGE SYSTEM
TARGET DATA
26
RESOURCE INFO
30
24.2
24.2
24N2
BACKUP STORAGE SYSTEM
CONTENTION CONTROLLER
BACKUP STORAGE MEDIUM/ MEDIA
28
34
USER INTERFACE
22

FIG. 4

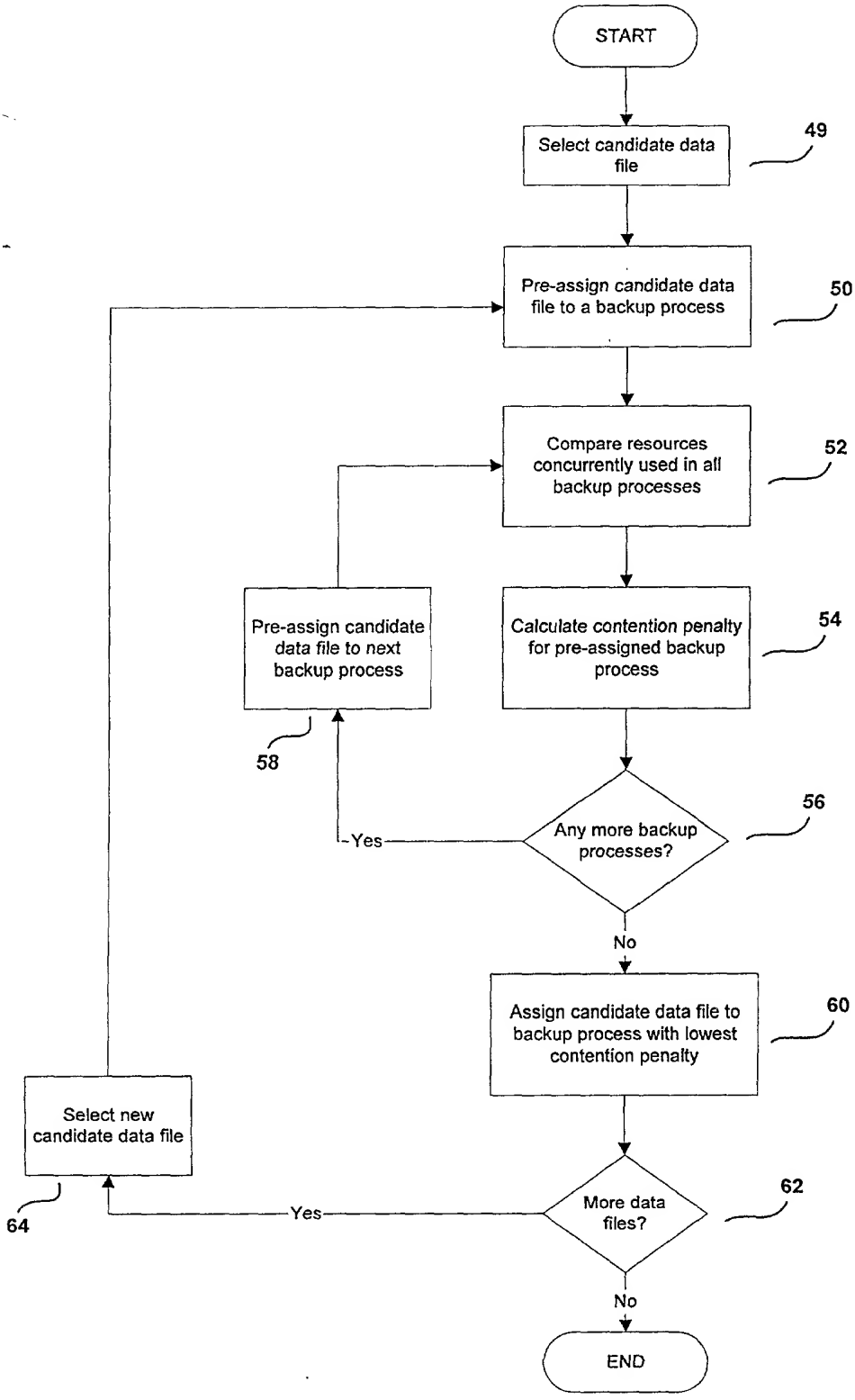
START
Select candidate data file
49
Pre-assign candidate data file to a backup process
50
Compare resources concurrently used in all backup processes
52
Calculate contention penalty for pre-assigned backup process
54
Pre-assign candidate data file to next backup process
58
Any more backup processes?
56
Yes
No
Assign candidate data file to backup process with lowest contention penalty
60
Select new candidate data file
64
More data files?
62
Yes
No
END

FIG. 5

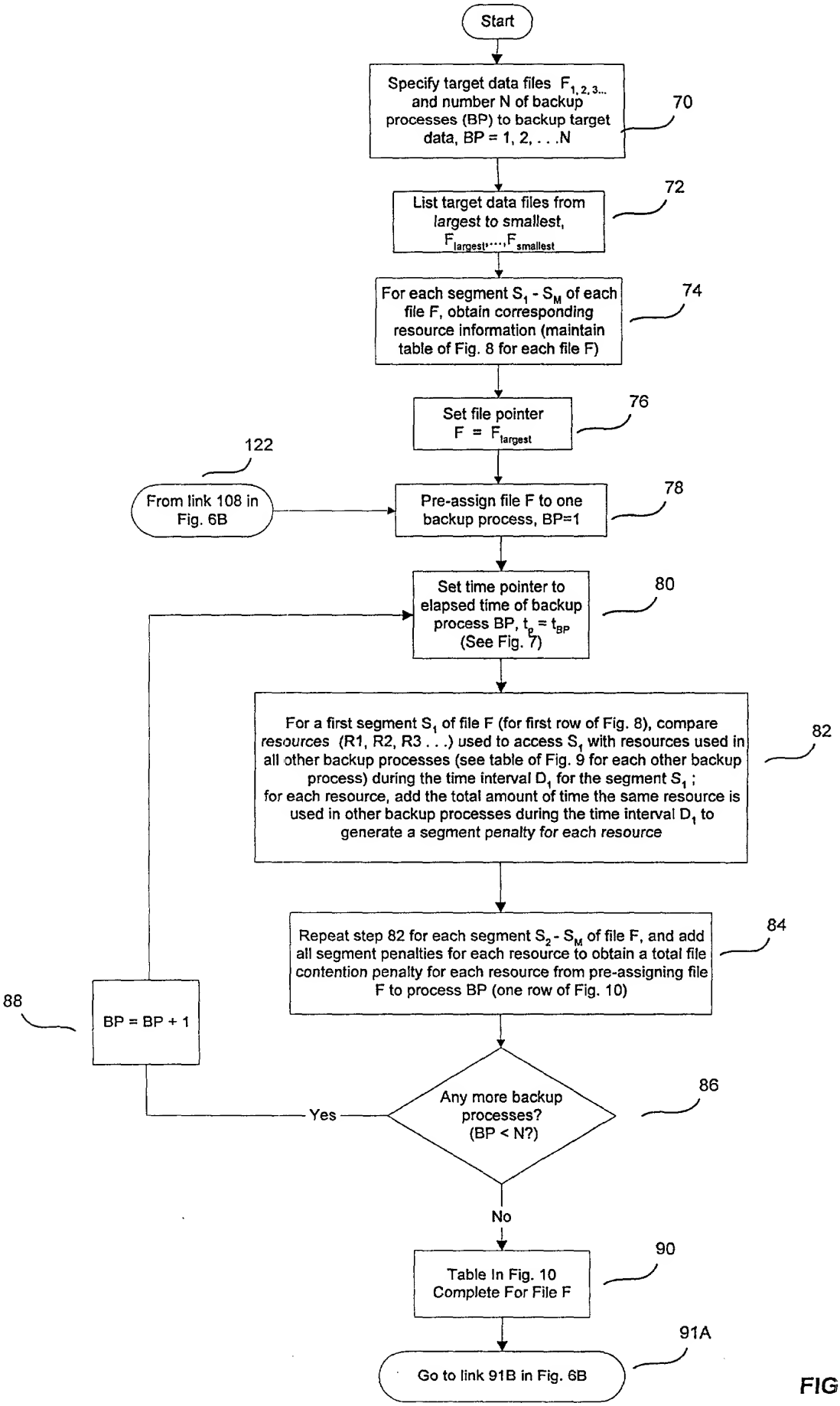
Start
Specify target data files $F_{1, 2, 3...}$ and number N of backup processes (BP) to backup target data, BP = 1, 2, . . .N
70
List target data files from largest to smallest, $F_{largest}, \ldots, F_{smallest}$
72
For each segment S_1 - S_M of each file F, obtain corresponding resource information (maintain table of Fig. 8 for each file F)
74
Set file pointer F = $F_{largest}$
76
122
From link 108 in Fig. 6B
Pre-assign file F to one backup process, BP=1
78
Set time pointer to elapsed time of backup process BP, $t_p = t_{BP}$ (See Fig. 7)
80
For a first segment S_1 of file F (for first row of Fig. 8), compare resources (R1, R2, R3 . . .) used to access S_1 with resources used in all other backup processes (see table of Fig. 9 for each other backup process) during the time interval D_1 for the segment S_1 ; for each resource, add the total amount of time the same resource is used in other backup processes during the time interval D_1 to generate a segment penalty for each resource
82
Repeat step 82 for each segment S_2 - S_M of file F, and add all segment penalties for each resource to obtain a total file contention penalty for each resource from pre-assigning file F to process BP (one row of Fig. 10)
84
88
BP = BP + 1
Any more backup processes? (BP < N?)
86
Yes
No
Table In Fig. 10 Complete For File F
90
91A
Go to link 91B in Fig. 6B

FIG. 6A

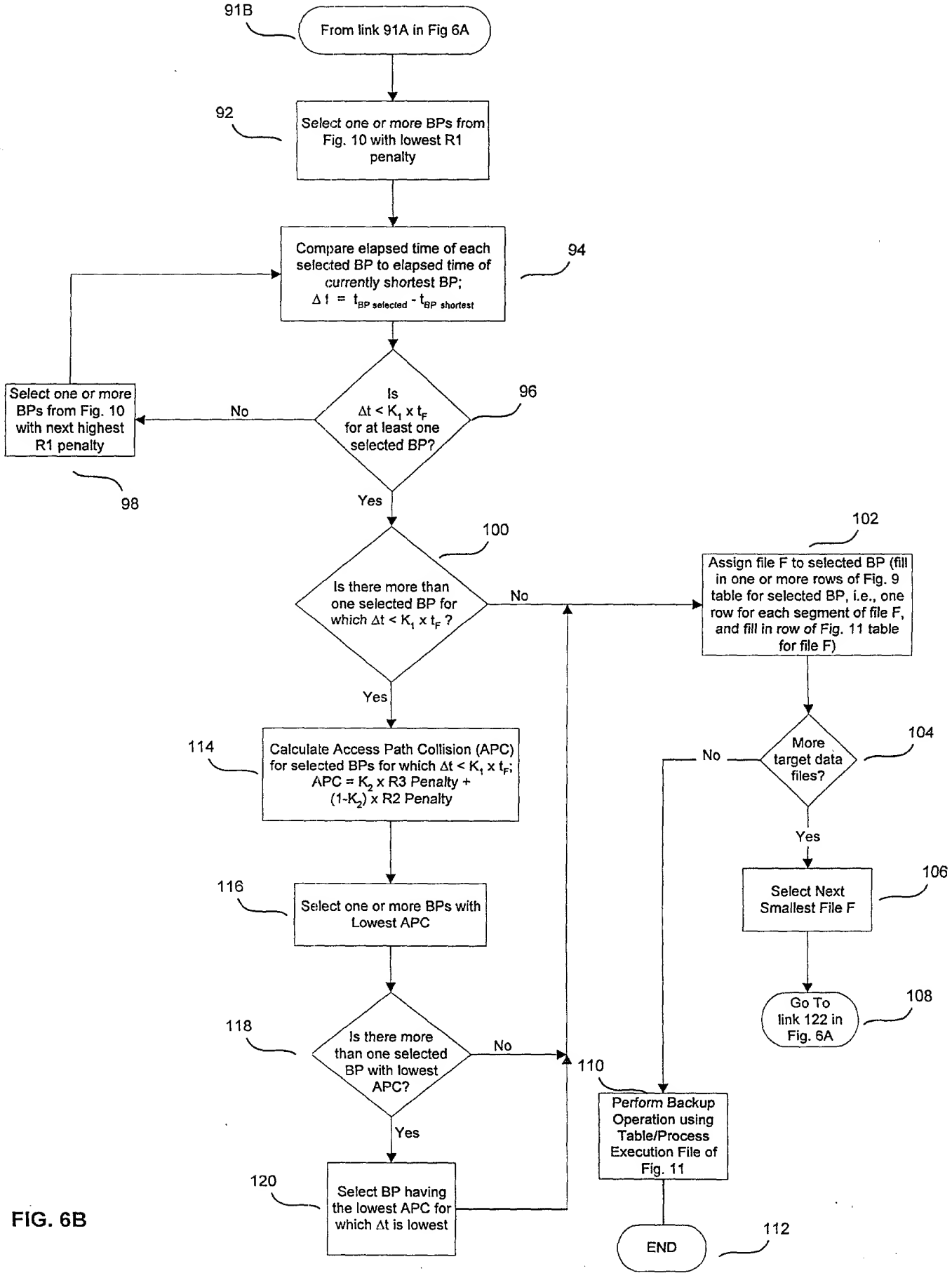
91B
From link 91A in Fig 6A
92
Select one or more BPs from Fig. 10 with lowest R1 penalty
Compare elapsed time of each selected BP to elapsed time of currently shortest BP;
$\Delta t = t_{BP\ selected} - t_{BP\ shortest}$
94
Is $\Delta t < K_1 \times t_F$ for at least one selected BP?
96
No
Select one or more BPs from Fig. 10 with next highest R1 penalty
98
Yes
Is there more than one selected BP for which $\Delta t < K_1 \times t_F$?
100
No
Yes
102
Assign file F to selected BP (fill in one or more rows of Fig. 9 table for selected BP, i.e., one row for each segment of file F, and fill in row of Fig. 11 table for file F)
More target data files?
104
No
Yes
Select Next Smallest File F
106
Go To link 122 in Fig. 6A
108
Calculate Access Path Collision (APC) for selected BPs for which $\Delta t < K_1 \times t_F$; $APC = K_2 \times R3\ Penalty + (1-K_2) \times R2\ Penalty$
114
Select one or more BPs with Lowest APC
116
Is there more than one selected BP with lowest APC?
118
No
Yes
Select BP having the lowest APC for which Δt is lowest
120
110
Perform Backup Operation using Table/Process Execution File of Fig. 11
END
112

FIG. 6B

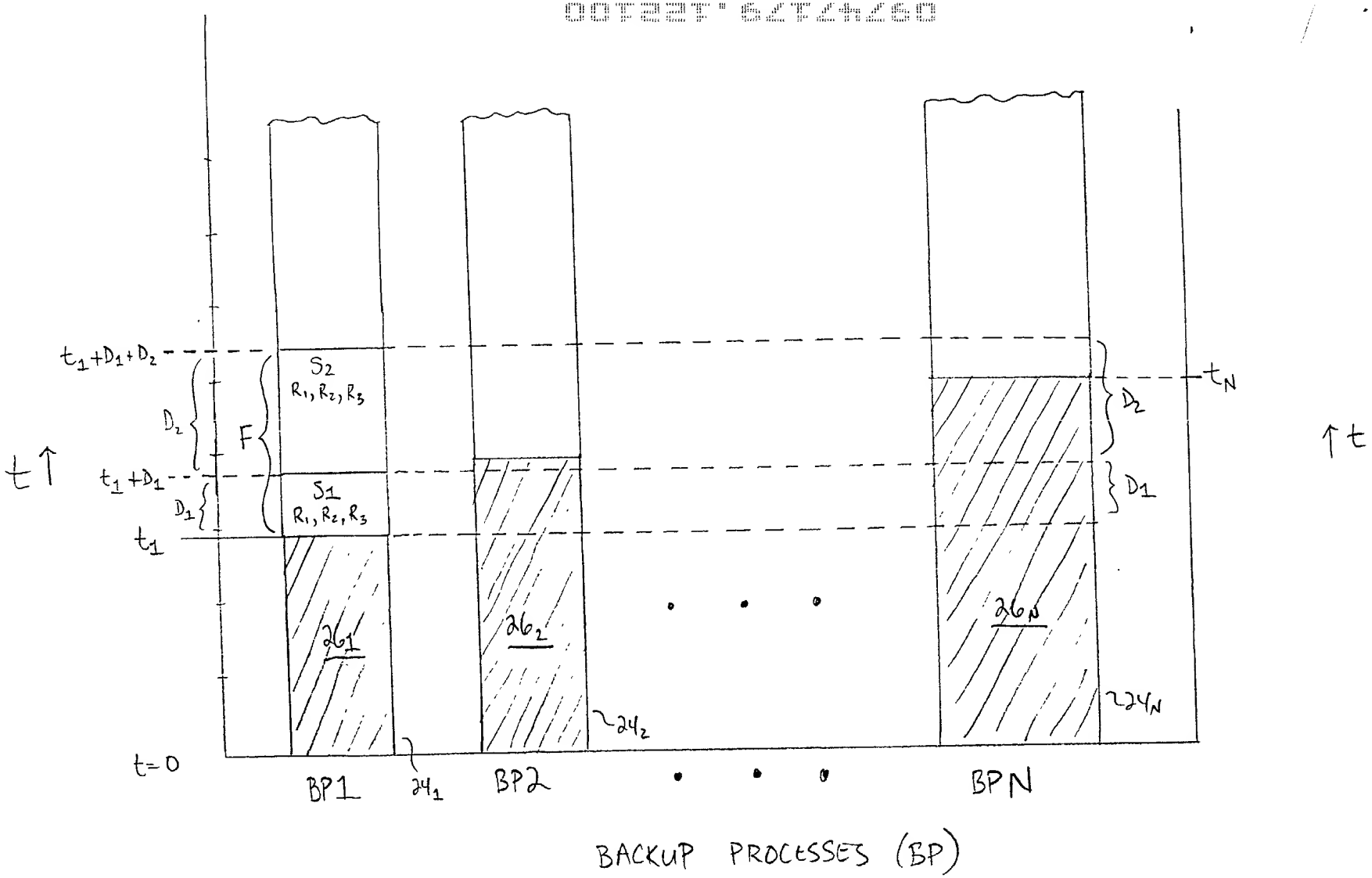
$t_1+D_1+D_2$
t_1+D_1
t_1
$t=0$
D_2
D_1
F
S_2
R_1, R_2, R_3
S_1
R_1, R_2, R_3
26_1
26_2
26_N
24_1
24_2
24_N
t_N
BP1
BP2
BPN
t↑
↑t
BACKUP PROCESSES (BP)

FIG. 7

Segment/ Duration	Spindle (R1) ID	DISC CONTROLLER (R2) ID	FRONT END CONTROLLER (R3) ID
$S1/10ms$	2	3	1
$S2/20ms$	6	2	2
$S3/D_3$			
$S4/D_4$			
⋮			
S_M/D_M			

FIG. 8

TIME t(ms)	SPINDLE ID (R1)	DISC CONTROLLER ID (R2)	FRONT END ID (R3)
0			
D_1			
D_1+D_2			
$D_1+D_2+D_3$			
.			
.			
.			
... $D_{M-2}+D_{M-1}+D_M$			

FIG. 9

BACKUP PROCESS (BP)	TOTAL SPINDLE (R1) PENALTY	TOTAL DA (R2) PENALTY	TOTAL FRONT END (R3) PENALTY
1			
2			
3			
N			

FIG. 10

FILE NAME	BACKUP PROCESS	ORDER IN PROCESS
$F_{largest}$		
⋮	⋮	⋮
$F_{smallest}$		

FIG. 11

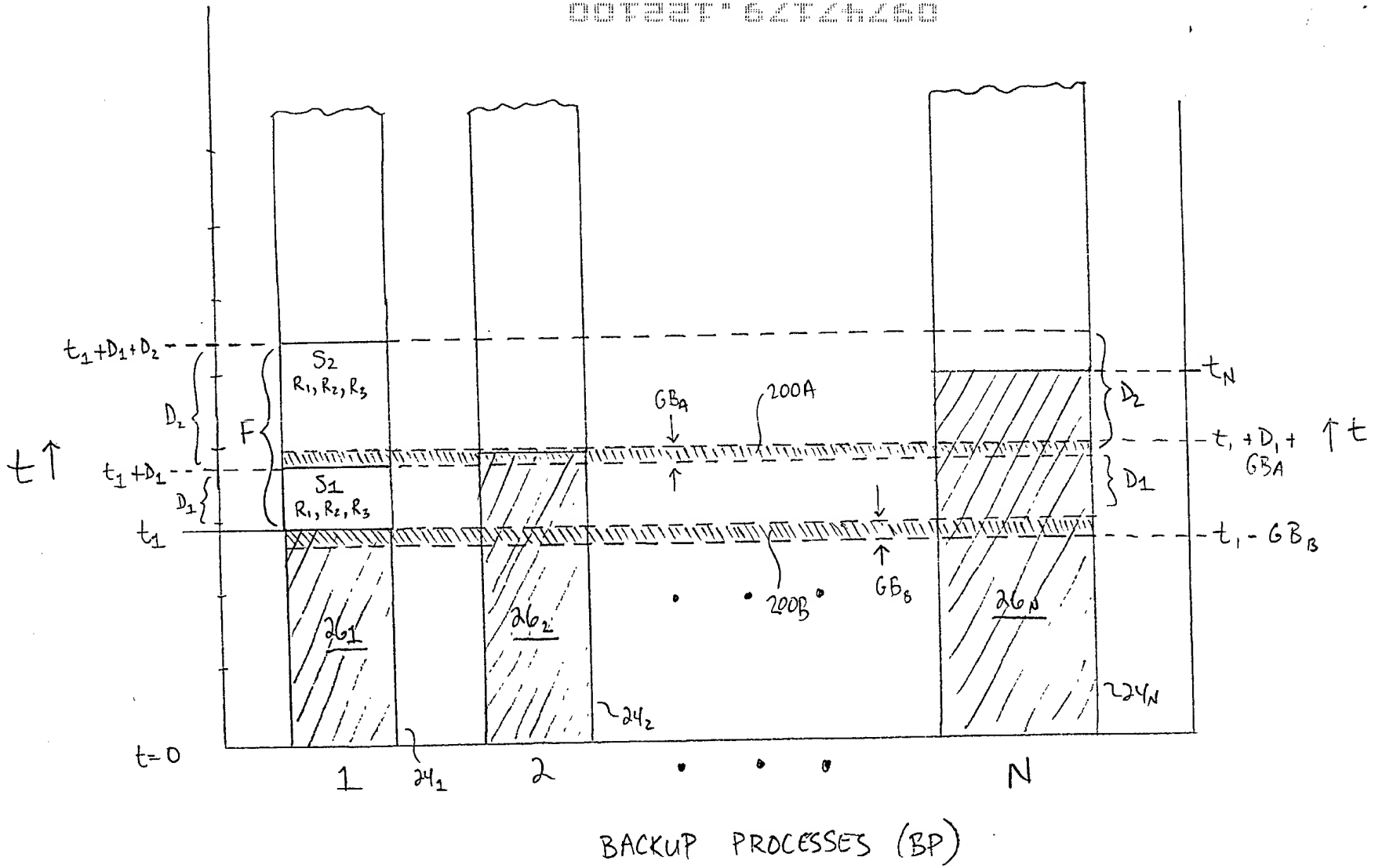
$t_1+D_1+D_2$
D_2
F
S_2
R_1, R_2, R_3
t_1+D_1
D_1
S_1
R_1, R_2, R_3
t_1
t=0
t↑
GB_A
200A
200B
GB_B
t_N
D_2
t_1+D_1+ GBA
D_1
t_1-GB_B
↑t
26_1
26_2
26_N
24_1
24_2
24_N
1
2
N
BACKUP PROCESSES (BP)

FIG. 12